

# Do changes within a manual therapy treatment session predict between-session changes for patients with cervical spine pain?

Neil Tuttle

Private Physiotherapy Practice and Griffith University

Physiotherapists often use within-session changes to provide a guide for refining treatment application. This study tested the validity of within-session changes as predictors of between-session changes for patients with neck pain receiving manual therapy treatment. A total of 70 pairs of treatments from 29 patients with sub-acute non-specific neck pain receiving manual therapy were assessed to determine the relationship between within-session and between-session changes in range of motion (ROM), pain intensity, and centralisation. Measurements were taken of ROM of the more limited direction on each axis of flexion, extension, lateral-flexion and rotation, and pain (intensity and location) before and after treatment. The same measurements were repeated before the following treatment. Regression analysis demonstrated that within-session change accounted for 26% to 48% of the variability in between-session change for ROM and six per cent for pain intensity. The proportion of the within-session change for ROM maintained between sessions ranged from 42% to 63% (95% CI 25% to 88%). The odds ratios for within-session improved/not improved categorisation to predict between-session category for ROM ranged from 2.5 (95% CI 0.6 to 4.3) to 21.3 (95% CI 10.1 to 96.1), for pain intensity 4.5 (95% CI 1.2 to 14.4) and for pain centralisation 9.2 (95% CI 2.2 to 38.7) indicating greater likelihood of between-session improvement after within-session improvement. The between-session results for most patients (71% to 83%) could be classified correctly by their within-session category. The results support the use of within-session changes in ROM, centralisation, and possibly pain intensity as predictors of between-session changes for musculoskeletal disorders of the cervical spine. [Tuttle N (2005): Do changes within a manual therapy treatment session predict between-session changes for patients with cervical spine pain? *Australian Journal of Physiotherapy* 51: 43–48.]

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## Introduction

Disorders of the cervical spine are amongst the most common sources of musculoskeletal symptoms (National Health and Medical Research Council 2003) with manual therapy being a commonly applied form of treatment. Studies into the effectiveness of manual therapy have, however, demonstrated inconsistent results. Randomised control trials are considered to have significant limitations when applied to complex conditions or when treatments are variable (Kotaska 2004). The lack of consistent results may thus partly be due to subgroups of patients having different responses to treatment (Grant 2002) as disorders of the cervical spine cannot at this point be grouped into functionally homogenous categories (National Health and Medical Research Council 2003), or to the difficulty in precisely controlling the intervention being applied. Even for surgical interventions precise control of procedures cannot be achieved to the same extent as for drug therapy (Birkmeyer et al 2002). For manual therapy the variation of method and skill is likely to be even greater between practitioners than amongst surgeons making standardisation of interventions even more difficult.

In the clinical setting the manual therapy practitioner is concerned with the intervention that will be most effective for a particular patient with a particular problem at a particular time. If all members of a group are presumed to be similar

and treatments consistent and repeatable, then treatment can reasonably follow set protocols. If, however, each patient's condition is considered to be a unique combination of elements, the treatment needs to be tailored to the individual patient and the response to treatment. Practitioners therefore require a sensitive means of gauging the response to interventions to guide their application and refinement.

Early manual therapy texts advised that effective treatment was gauged by the segmental mobility of the spine, as assessed by the practitioner, being improved to its normal level. The usefulness of relying solely on segmental mobility as an assessment is undermined by its poor reliability (National Health and Medical Research Council 2003) as well as difficulty in ensuring that the reduced segmental mobility is related to the patient's symptoms and is not an incidental finding.

Immediate changes in the intensity or location of the patient's pain are commonly used to assess changes in the patient's condition. Location of symptoms is encouraged as an assessment measure in the McKenzie method where centralisation of the patient's symptoms is considered to be a key indicator of improvement. Several articles have concluded that within-session centralisation of a patient's symptoms is a valid predictor of treatment success (Aina et al 2004; Werneke and Hart 2001; Werneke and Hart 2003; Werneke et al 1999). However, Walsh (2001) suggested that

the results may only demonstrate 'that a lack of centralisation predicts a lack of response to McKenzie treatment, not necessarily a poor outcome.'

Another method of attempting to evaluate the effectiveness of treatment is by the therapist assessing a movement that is limited by the patient's symptoms. This method, initially proposed by Maitland (1964) and still advocated today (Ferrario et al 2002), is taught in all postgraduate manual therapy courses in Australia (Hahne et al 2004). In its simplest form the practitioner selects a movement or function limited by the patient's symptoms that can be reassessed easily and objectively. This clinical test movement is reassessed at the beginning and end of each treatment session and commonly after individual components of the treatment. Changes in the test movement are used to gauge the effectiveness of the intervention and the therapist then modifies the treatment according to the direction and extent of these changes. Changes in range of motion take precedence over changes in the person's level of pain. That is, if patients have greater ROM but experience more pain at the limit of this increased ROM they are considered to be better.

Maitland's method would seem to have face validity, but there are a number of underlying assumptions. Reduced movement is assumed to be associated with a patient's symptoms and this is true for at least some types of neck pain (Dall'Alba et al 2001). Within-session changes are presumed to occur and several studies have confirmed that immediate changes do occur following manual therapy of the cervical spine (Cassidy et al 1992, Cassidy et al 1992, Whittingham and Nilsson 2001). A more important assumption is that within-session changes are valid predictors of between-session changes; in other words that there is some lasting change associated with these immediate changes. For the lumbar spine Hahne et al (2004) have found that within-session changes in ROM and pain intensity predict between-session changes. It is also known for the lumbar spine that changes in ROM correlate with changes in other outcome measures (Hagg et al 2002, Mannion et al 2003). Werneke and Hart (2003) have found that within-session centralisation of pain predicts between-session changes for both the lumbar and cervical spines when using a McKenzie method of treatment. It has not, however, been determined whether within-session centralisation or changes in ROM or pain predict between-session changes with manual therapy treatment of the cervical spine.

This study is designed to address the question of whether within-session changes in range of active movement are a valid basis for decision-making when treating musculoskeletal conditions of the cervical spine by manual therapy. In particular, do within-session changes in active ROM or pain predict between-session changes in the same parameters?

## Method

Research procedures were approved by the Ethics Review Committee, James Cook University.

**Subjects** All patients presenting to a private physiotherapy clinic who fulfilled the selection criteria were offered the opportunity to participate in the study. The inclusion criteria were: patients with neck pain, with or without referral of symptoms into the shoulder or arm, that was accompanied by a limitation of neck mobility. In order to reduce the amount of spontaneous change the patients were likely to experience,

only those whose symptoms had been present for more than two weeks were included. Patients were excluded if they had any condition which contraindicated the use of manual therapy treatments, or had any inflammatory or other medical condition that was likely to impact on their symptoms. Patients were also excluded if their symptoms were subject to compensation, were a result of trauma within the previous six months, or if they had received any physical treatment within the previous two weeks. Twenty-nine subjects were recruited over a seven-month period and consisted of 21 females and 8 males with an average age of 55 years (SD = 17, range 28 to 83).

**Procedures** Data from pairs of consecutive treatments were collected up to a maximum of six treatments or until the patient or therapist felt that manual therapy treatment was no longer required, other types of treatment were indicated, or when greater than two weeks passed between-sessions. A total of 70 pairs of treatments (mean time between treatments 6.1 days, range 2 to 14) met the criteria and were used for analysis. A staff member other than the treating therapist gave each patient a form before each treatment including two pain measures: 1) an eleven point visual analogue pain scale (VAS) of the current pain ranging from 0 being 'no pain' to 10 being 'worst pain imaginable'; 2) a body chart showing the location of the symptoms. The treating therapist set up the instrumented assessments of each patient's ROM before and after each treatment but did not have access to the resulting measurements. After each treatment the patient filled out a second form similar to pre-treatment. Thus not only were the assessors of the pain scales (VAS and body chart) and ROM blind to each other, but the treating therapist was blinded to both measurements.

The patients were treated by one of three physiotherapists with one, five, and 30 years experience. The study was not intended to assess the effectiveness of treatment, but rather the relationship of within-session changes to between-session changes. Therefore no attempt was made to standardise the treatment each patient received except to ensure that the intervention consisted predominantly of manual therapy, but could include within-session exercises. Manual therapy was defined as described by Korthals-de Bos et al (2003) consisting of 'hands-on techniques (muscular mobilisation, specific articular mobilisation, coordination or stabilisation). Spinal mobilisation was defined as low velocity passive movement within or at the limit of joint ROM. Spinal manipulation (low amplitude, high velocity techniques [were] not provided.' The therapist did not alter or suggest any alteration in the patient's medication. Patient education was provided as appropriate, but in order to minimise the influence of factors outside of the actual treatment, advice on exercises was limited to general advice on monitoring activities.

**Measurements and apparatus** A variety of methods have been used to measure cervical ROM comparing the relative positions of the head with landmarks intended to indicate the position of the first thoracic vertebrae (Hagen et al 1997, Feipel et al 1999, Dvir and Prushansky 2000, Jordan et al 2000, Ferrario et al 2002). Although the values obtained with the various methods vary, the repeatability is similar to the results obtained when the trunk is stabilised and the change in the position of the head in space is measured (Castro et al 2000, Ferrario et al 2002, Sforza et al 2002). For the current study, the change in ROM was important rather than the absolute value of ROM so the simpler method of ensuring

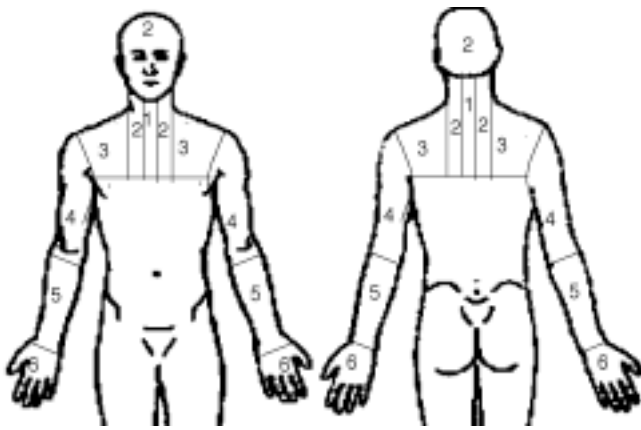


Figure 1. Overlay body template

stability of the trunk rather than stability of the first thoracic vertebrae was used. The patient was seated in a high-backed chair with his or her shoulders against the backrest and a 3-axis orientation sensor<sup>a</sup> attached to the head and interfaced with a PC. Purpose-built software using Labview v6i<sup>b</sup> was used for data acquisition at a sampling rate of 10 Hz. The system was zeroed by having the patient look straight ahead and three consecutive readings were averaged. The patient was then asked to perform three movements as far as he or she could reasonably move in flexion, extension, and to each side in lateral flexion and rotation. The maximum value for each movement was stored automatically and remained unknown to the therapist. Tests for repeatability of the measurements were performed on four asymptomatic volunteers. The mean difference between the first and second repeated measures was -1.2 degrees and the 95% limits of agreement (the range within which 95% of repeated measures would be expected to lie) (Bland and Altman 1999) was -5.9 degrees to +3.5 degrees. To simplify analysis a slightly larger difference of +5 degrees was considered to be the smallest detectable improvement. The location of the patient's pain (body chart) was assessed at rest and analysed using the method described by Werneke et al (1999). A body chart with regions numbered one through six on a clear plastic overlay (Figure 1) was placed over each body chart filled out by the patient and the number of the region containing the most distal symptoms was recorded.

**Data analysis** For each of the three parameters (ROM, VAS, and body chart), the within-session change was the difference between the measurements taken before and after each treatment and the between-session change the difference between the measurements taken before one treatment and before the following treatment. When ROM is used to assess change in the clinical setting, typically the direction of movement that is more limited (the so-called asterisk movement (Maitland 1964, Refshauge and Gass 2004)) is used for reassessment. Therefore the within- and between-session changes were calculated for the direction of movement that, prior to treatment, was more limited for each

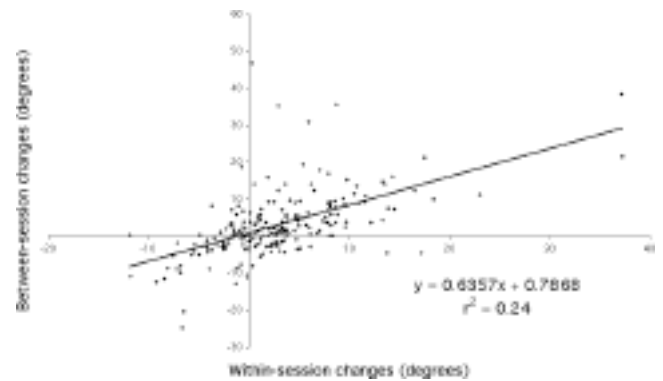


Figure 2. The relationship between within-session and between-session change in the limited directions of ROM. All three axes of movement for all patients ( $n = 210$ ) are shown. Although most within-session changes were within  $\pm 10$  degrees, some patients improved by over 15 degrees in a single direction of movement in a single treatment.

axis (limited flexion/extension, limited lateral flexion, and limited rotation). If the patient received more than one treatment the direction of movement limited before the first treatment was used for future sessions.

Pearson correlation coefficients were used to assess the relationships of within-session changes to between-session changes for each ROM variable and VAS. For those pairs where significant relationships occurred a simple linear regression was performed. Confidence intervals were calculated to assist in determining the clinical relevance of the relationships.

Odds ratios and positive and negative likelihood ratios were calculated to assess the likelihood of simple improvement within-sessions being retained between-sessions for ROM, VAS, and body chart variables. For ROM, patients were classified as better if they had an improvement greater than the smallest detectable improvement determined from pilot data (5 degrees). For ease of comparison, improvement in VAS and centralisation were defined in the same way as in previous comparable studies where these parameters were assessed. For VAS this was a reduction of more than one point (Hahne et al 2004), and for pain centralisation movement proximally by at least one category (Werneke et al 1999, Werneke and Hart 2003). Otherwise patients were classified as not improved. Although reducing the ROM and VAS data to two categories significantly degrades the data and reduces the sensitivity of the analysis, this categorisation enabled a direct comparison between these parameters and the body chart, as well as enabling a direct comparison with data from other studies (Hahne et al 2004). A significance level was set at  $p < 0.05$  for all tests. Data analysis was performed using Microsoft Excel 2000<sup>c</sup>, SPSS v12.1<sup>d</sup> and Vassarstats (Lowry 2004).

## Results

**Descriptive statistics** for scalable variables are shown in Table 1. All within-session and between-session variables show a mean improvement in both ROM and VAS. The



**Table 1.** Mean pre-session values, within-session changes and between-session changes.

	Mean pre-session value (SD)	Mean within-session change (SD)	Mean between-session change (SD)
Limited flexion/extension	45.0 degrees (13.5)	4.3 degrees (9.0)	7.6 degrees (14.6)
Limited lateral-flexion	31.7 degrees (11.1)	1.4 degrees (4.4)	2.2 degrees (11.4)
Limited rotation	63.4 degrees (10.5)	3.3 degrees (5.0)	5.0 degrees (13.2)
Pain intensity (VAS)	4.1 points (2.2)	-0.9 points (1.6)	-0.8 points (1.9)

For each movement the between-session change is larger than the within-session change. The simple averages shown here give an indication of the small size of the between-session changes in relation to the large between-session variance. VAS, visual analogue scale.

**Table 2.** Linear regression analysis of the relationships between within-session changes and between-session changes in the limited directions of movement and pain intensity.

	Coefficient of determination $r^2$	Slope (95% CI)	Intercept in degrees (95% CI)
Limited F/E	0.26	0.63 (0.37 to 0.88)	2.79 (0.25 to 5.33)
Limited LF	0.26	0.42 (0.25 to 0.59)	2.05 (-0.05 to 4.15)
Limited ROT	0.48	0.43 (0.32 to 0.54)	2.23 (1.33 to 3.14)
Pain intensity (VAS)	0.06	0.30 (0.01 to 0.58)	-0.48 (-1.00 to 0.04)

The coefficient of determination ( $r^2$ ) is the proportion of variance in between-session change that is predicted by within-session change. Slope is the proportion of the within-session change that is maintained between-sessions (a slope of 1 indicates that all of the change within-session was maintained while a slope of 0.5 indicates that 50% of the within-session change was maintained.) The intercept is the change between-sessions that is unrelated to the size of any within-session change. FE, flexion/extension. LF, lateral flexion. ROT, rotation. VAS, visual analogue scale.

standard deviation is greater than the mean change in all cases demonstrating the large variability in between-session measures.

**Within-session changes for each variable** were related to between-session changes of the same variable. Figure 2 shows the relationship between within-session change and between-session change for all ROM variables. The coefficient of determination ( $r^2$ ), intercept and slope values from linear regression analysis for each pair of ROM and VAS variables are shown in Table 2. The  $r^2$  values indicate that within-session changes accounted for 22% to 48% of the between-session change in each ROM measurement and 6% of the change in pain intensity. The intercepts representing the amount of between-sessions change unrelated to the size of the within-session change were less than 3 degrees for the ROM variables. The slopes indicate that 42% to 63% (95% CI 25% to 88%) of the within-session change in ROM was retained between-sessions.

**Accuracy, odds, and likelihood ratios** Table 3 shows the ability of each within-session category (improved/not improved) to predict between-session category for the same variable is between 63% and 83%. The likelihood and odds ratios show that for all variables except the limited direction of lateral-flexion, within-session improvements predict between-session improvements. The lack of significance for lateral flexion may be due to the small number of patients who were categorised as improved for this variable.

## Discussion

Within-session change predicted between-session change for each of the parameters and the size of within-session change was related to the size of between-session change for ROM and pain intensity.

**Strengths and weaknesses** The question under investigation was related to methods of assessment rather than a comparison of outcomes between groups so a control group was not necessary. The types of treatment provided, however, were restricted as mechanisms and effects of different treatments for musculoskeletal neck pain may vary. Care would need to be exercised in generalising the results of this study to other settings or interventions as treatment was provided in one setting by one of only three practitioners all of whom work in a similar style based on a Maitland approach. Other influences on outcomes may have occurred within the treatment session besides the intended treatment and modalities other than manual therapy were not completely excluded. Therefore it cannot be certain that within or between treatment changes were related to the manual therapy aspect of the treatment. It is also important to recognise that although within-session changes predict between-session changes, it is not possible to deduce a cause and effect relationship. A strength of this study is that patients had subacute symptoms, so spontaneous changes in their symptoms would be less pronounced than with more acute patients. In addition patients received real-world treatment

**Table 3.** Likelihood and odds ratios.

	Accuracy	+LH (95% CI)	-LH (95% CI)	Odds ratio (95% CI)
Limited flexion/extension*	73%	3.7 (1.7 to 8.2)	0.5 (0.3 to 0.7)	8.0 (2.4 to 26.8)
Limited lateral-flexion	74%	2.1 (0.7 to 6.2)	0.8 (0.6 to 1.1)	2.5 (0.6 to 10.1)
Limited rotation*	83%	5.0 (2.6 to 9.9)	0.2 (0.1 to 0.6)	21.3 (4.3 to 96.1)
Pain intensity (VAS)*	71%	2.5 (1.3 to 4.6)	0.6 (0.3 to 0.9)	4.5 (1.2 to 14.4)
Pain centralisation (body chart)*	77%	3.3 (1.8 to 6.1)	0.4 (0.2 to 0.8)	9.2 (2.2 to 38.7)

Accuracy is the percentage of sessions where the between-session change was correctly categorised by the within session change. The positive likelihood ratio (+LH) is the factor by which the odds of between-session improvement is increased if improvement occurred within-session. The negative likelihood ratio (-LH) is the factor by which odds of between-session improvement is reduced if no within-session improvement occurred. \* denotes significance ( $p < 0.05$ ).

that was not influenced by their participation in the study except by the treatment being 'book-ended' by additional assessment items before and after each treatment session.

There were no significant differences in the ability of the different within-session parameters to predict between-session change. Small between-session changes are difficult to detect when they are superimposed on the large variability that occurs in the between-session measures of ROM and pain. The more precise the measurement, the more likely it would be able to detect small changes. In the clinical setting, assessments of pain intensity and centralisation may be able to be more sensitive than the methods used in this study enabling smaller changes to be detected. The results of this study may therefore underestimate the effectiveness of within-session changes in pain intensity and centralisation to predict between-session changes.

**Findings in relation to previous studies** The  $r^2$  values expressing the proportion of the variation occurring between-sessions that is accounted for by within-session change were consistent with those found for the lumbar spine (Hahne et al 2004) with ROM accounting for more of the variation than pain. It is important to note that the current study assessed resting pain before and after treatment whereas the study by Hahne et al (2004) used level of pain with each movement. The relatively small proportion of variation in between-sessions changes accounted for by within-session changes was not unexpected considering the variety of patient experiences between sessions that cannot be taken into account in the experimental design. For example, in the current study one patient had a fall and lost consciousness, and another cut off part of a finger with a chain saw. The slope of the linear regression is an important aspect of the analysis which does not appear to have been reported on elsewhere. The range of slopes for the regression lines found in this study reinforce the variability of how much within-session change is maintained between sessions.

The odds and likelihood ratios in the current study of the cervical spine were similar, but generally smaller than those found by Hahne et al (2004) for ROM and pain in the lumbar spine. This may be a result of differences between responses of the cervical and lumbar spines or may be due to patients with more acute symptoms being included in the previous study.

Previously it was known that immediate changes in ROM and pain intensity occur following manual therapy treatment. The current study has shown that immediate changes in these parameters relate to between-session changes — at least if one is reassessing the same measurement and considering treatments predominantly by manual therapy. Previously it was known that centralisation of pain assessed using repeated movements was able to predict longer-term changes when treatment was performed according to the McKenzie method. The current study has shown that within-session centralisation was also able to predict between-session centralisation for patients treated with manual therapy.

**Implications of results** This study has shown that the direction and the size of between-session changes in ROM and, to a lesser extent, pain intensity are predicted by within-session changes. The results support the use of within-session changes in ROM, centralisation, and possibly pain intensity as predictors of between-session changes for musculoskeletal disorders of the cervical spine. These findings combined with similar findings from previous studies of the lumbar spine support the use of within-session changes as a means of predicting the likelihood of a positive outcome. Being able to predict between-session changes in a single parameter as found in this study is of limited practical use unless the between-session changes correspond to longer-term functional outcomes. For example, centralisation of pain within two treatment sessions has been shown in some circumstances to predict treatment outcomes. The next stage in assessing the relative usefulness of ROM, pain intensity and centralisation is to determine each parameter's ability to predict longer-term treatment outcomes. Further analysis of data from the population in this study is currently being undertaken to begin to answer this question.

**Footnotes** <sup>a</sup>3DM MicroStrain Inc, 310 Hurricane Lane, Williston, VT <sup>b</sup>National Instruments Corporation, 11500 N Mopac Expwy, Austin, TX 78759-3504 <sup>c</sup>Microsoft Corporation, One Microsoft Way, Redmond, WA 98052-6399 <sup>d</sup>SPSS Inc, 444 N Michigan Ave, Chicago, IL, 60611

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**Correspondence** Neil Tuttle, PO Box 567, Mudgeeraba, QLD 4213. Email: <n.tuttle@griffith.edu.au>

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